

WHAT IS CLAIMED IS:

1                    1.        A catheter system for controlling the temperature of a patient, the  
2 catheter system comprising:

3                    a catheter having a shaft and a heat exchange region;

4                    an on-board temperature probe, said temperature probe having a temperature  
5 sensor and a signal carrying mechanism such that when said catheter is inserted into the body  
6 of a patient such that said heat exchange region is located inside the body of said patient, said  
7 signal carrying mechanism extending from said sensor to a location outside of the body of the  
8 patient;

9                    said probe having an undeployed configuration and a deployed configuration,  
10 said probe movable between said undeployed configuration and said deployed configuration  
11 such that when the probe is in said deployed configuration, said sensor is located farther away  
12 from said catheter body than when said probe is in said undeployed configuration.

1                    2.        A catheter system in accordance with claim 1 wherein said probe is  
2 movable between said undeployed and said deployed configuration without any operator  
3 intervention.

1                    3.        A catheter system in accordance with claim 1 wherein said probe is  
2 movable between said undeployed and said deployed configuration by operator intervention.

1                    4.        A catheter system in accordance with claim 1 wherein said temperature  
2 sensor is a thermistor.

1                    5.        A catheter system in accordance with claim 1 wherein said temperature  
2 probe comprises a plurality of temperature sensors.

1                    6.        A catheter system in accordance with claim 1 wherein said temperature  
2 probe comprises shape memory material.

1                    7.        A catheter system in accordance with claim 6 wherein said temperature  
2 probe comprises nitinol.

1                   8.       A catheter system in accordance with claim 6 wherein said temperature  
2 probe comprises shape memory polymers.

1                   9.       A catheter system in accordance with claim 1, further comprising a  
2 controller, said temperature sensor generating a signal representing a sensed temperature, said  
3 signal carried from said sensor to said controller by said signal carrying mechanism, said  
4 controller controlling the heat exchanged between said heat exchange region and the blood of  
5 said patient in response to said signal.

1                   10.      A catheter system in accordance with claim 9 wherein said catheter  
2 system comprises a fluid flow heat exchange catheter having the temperature of said heat  
3 exchange region affected by flowing heat exchange fluid, said controller controlling the  
4 temperature of said heat exchange region by controlling the temperature of said heat  
5 exchange fluid.

1                   11.      A catheter system in accordance with claim 9 wherein said catheter  
2 system comprises a fluid flow heat exchange catheter having the temperature of said heat  
3 exchange region affected by flowing heat exchange fluid, said controller controlling the  
4 temperature of said heat exchange region by controlling the rate of flow of said heat  
5 exchange fluid.

1                   12.      A catheter system for sensing the temperature of a patient, the catheter  
2 system comprising:

3                   a catheter having a shaft and a heat exchange region;

4                   a temperature probe lumen, the lumen defining an aperture that is located  
5 proximal of the heat exchange region; and

6                   a deployable temperature probe, the temperature probe including a  
7 temperature sensor and a signal carrying mechanism that extends from the sensor to a  
8 location outside of the patient, the temperature probe having an undeployed configuration and  
9 a deployed configuration, the temperature probe being movable between the undeployed and  
10 deployed configurations;

11                    wherein when the temperature probe is in the deployed configuration, the  
12 temperature sensor is located further from the shaft than when the temperature probe is in the  
13 undeployed configuration; and

14                    wherein the temperature sensor generates a signal representing a sensed  
15 temperature and the signal carrying mechanism transmits the signal from the temperature  
16 sensor to the location outside the patient.

1                    13.     A catheter system in accordance with claim 12 wherein the  
2 temperature sensor comprises a thermistor.

1                    14.     A catheter in accordance with claim 13 wherein the temperature sensor  
2 comprises a second thermistor.

1                    15.     A catheter system in accordance with claim 12 wherein the catheter is  
2 a fluid flow heat exchange catheter whereby the temperature of the heat exchange region is  
3 controlled by a flow of heat exchange fluid.

1                    16.     A catheter system in accordance with claim 15 wherein the shaft  
2 includes fluid flow lumens for flow of heat exchange fluid to the heat exchange region.

1                    17.     A catheter system in accordance with claim 12 wherein the  
2 temperature probe is deployed by an operator.

1                    18.     A catheter system in accordance with claim 17 wherein the  
2 temperature probe is moved to the deployable configuration by removing a constraint that  
3 constrains the amount of movement of the temperature probe within the temperature probe  
4 lumen.

1                    19.     A catheter system in accordance with claim 17 wherein the  
2 temperature probe is deployed to the deployed configuration by at least one pull wire.

1                    20.     A catheter system in accordance with claim 17 wherein the  
2 temperature probe is in the from of a tube containing thermistor wires.

1                    21.     A catheter system in accordance with claim 12 wherein the  
2 temperature probe is automatically deployed between the undeployed configuration and the  
3 deployed configuration.

- 1                    22.     A catheter system in accordance with claim 21 wherein the  
2     temperature probe is heat activated.
- 1                    23.     A catheter system in accordance with claim 22 wherein the  
2     temperature probe comprises nitinol.
- 1                    24.     A catheter system in accordance with claim 21 wherein the  
2     temperature probe is spring activated.
- 1                    25.     A catheter system in accordance with claim 21 wherein the  
2     temperature probe includes a biodegradable restraining element.
- 1                    26.     A catheter system in accordance with claim 12 wherein the  
2     temperature probe lumen is within the catheter shaft and coupled thereto.
- 1                    27.     A catheter system in accordance with claim 12 wherein the  
2     temperature probe lumen is external to the catheter shaft and coupled thereto.
- 1                    28.     A catheter system in accordance with claim 27 wherein the  
2     temperature probe lumen extends along only a portion of the catheter shaft.
- 1                    29.     A catheter system in accordance with claim 27 wherein the  
2     temperature probe lumen extends along an entire length of an inserted portion of the catheter  
3     shaft.
- 1                    30.     A catheter system in accordance with claim 12 wherein the  
2     temperature probe lumen is incorporated within the catheter shaft and wherein the  
3     temperature probe lumen is extruded with the catheter shaft and is within the outer diameter  
4     of the shaft.
- 1                    31.     A catheter system in accordance with claim 12 wherein the aperture is  
2     located at a distal end of the temperature probe lumen.
- 1                    32.     A catheter system in accordance with claim 31 wherein the aperture  
2     comprises a ramp.
- 1                    33.     A catheter system in accordance with claim 32 wherein the ramp  
2     includes a shaped surface and the temperature probe includes a mating sensor.

1                    34.     A catheter system in accordance with claim 33 wherein the shaped  
2 surface is flat.

1                    35.     A catheter system in accordance with claim 12 wherein the sensor is in  
2 a range of 1.8 - 3.2 mm from the catheter shaft when the temperature probe is in the deployed  
3 configuration and is within the outer diameter of the catheter shaft when the temperature  
4 probe is in the undeployed configuration.

1                    36.     A catheter system in accordance with claim 12 further comprising a  
2 controller for receiving the signals from the signal carrying mechanism, the controller being  
3 configured to use the signals to control the body temperature of the patient by modifying the  
4 temperature of blood flowing within a blood vessel of the patient.

1                    37.     A catheter system in accordance with claim 12 wherein the catheter  
2 includes an atraumatic tip.

1                    38.     A catheter system for controlling the temperature of a patient, the  
2 catheter system comprising:

3                    a heat exchange catheter for placement in the flowing bloodstream of a  
4 patient, said catheter having a heat exchange region thereon;

5                    an on board temperature probe, said probe containing temperature sensors and  
6 signal carrying mechanisms, said signal carrying mechanisms extending from said sensors to  
7 a controller, said probe having an undeployed configuration and a deployed configuration, the  
8 temperature probe being movable between the undeployed and deployed configurations,  
9 wherein when the temperature probe is in the deployed configuration, the temperature sensor  
10 is located upstream in the bloodstream of the patient and further from the shaft than when the  
11 temperature probe is in the undeployed configuration;

12                    wherein the temperature sensor generates a signal representing a sensed  
13 temperature of the blood in the bloodstream, and the signal carrying mechanism transmits the  
14 signal from the temperature sensor to the controller; and

15                    said controller controls the temperature of said heat exchange region in  
16 response said signal.

39. A method of monitoring the body temperature of a patient by monitoring the temperature of blood flowing within a blood vessel of the patient, the method comprising:

advancing a catheter body comprising a temperature probe lumen that extends along a catheter shaft and that includes an opening defined at a distal end portion into the patient's blood vessel such that the opening is in contact with the patient's blood; and

deploying a temperature probe from within the temperature probe lumen such that a distal end portion of the deployable temperature probe protrudes through the opening into the blood flowing within the blood vessel.

40. A method in accordance with claim 39 wherein the deployable temperature probe comprises shape memory material at a tip portion at the distal end portion such that when it warms, it curves through the opening.

41. A method in accordance with claim 39 wherein the distal end of the temperature probe lumen includes a ramp coupled to the opening thereby guiding the distal end portion through the opening.

42. A method in accordance with claim 39 wherein the temperature sensed is venous blood.

43. A method in accordance with claim 41 wherein the blood vessel is the inferior vena cava.

44. A method in accordance with claim 41 wherein the blood vessel is the femoral vein.

45. A method of controlling the body temperature of a patient by monitoring the temperature of blood flowing within a blood vessel of the patient, the method comprising:

advancing a catheter body comprising a temperature probe lumen that extends along a catheter shaft and that includes an opening defined at a distal portion of said lumen, said opening between said lumen and the patient's blood vessel such that the opening is in contact with the patient's blood;

8                    deploying a temperature probe, said temperature probe having a temperature  
9    sensor, from within the temperature probe lumen such that said temperature sensors  
10   protrudes through the opening into the blood flowing within the blood vessel;  
  
11                    generating a signal from said temperature sensor representing the temperature  
12   of the blood; and  
  
13                    providing said signal to a controller.

1                    46.    A method in accordance with claim 45 wherein the distal end of the  
2    temperature probe lumen includes a ramp coupled to the opening thereby guiding the distal  
3    end portion through the opening.

1                    47.    A method in accordance with claim 45 wherein the catheter includes a  
2    heat exchange region and the temperature of said heat exchange region is controlled by  
3    flowing fluid between the controller and the heat exchange region.

1                    48.    A method in accordance with claim 46 wherein the controller controls  
2    at least one of a temperature of the heat exchange fluid and a rate of fluid flow of the heat  
3    exchange fluid.